Catalogue of American Amphibians and Reptiles.

Dorcas, M.E., J.W. Gibbons, and H.G. Dowling. 1998. *Seminatrix, S. pygaea.*

Seminatrix Cope
Black Swamp Snake

Seminatrix Cope 1895:678. Type species, *Contia pygaea* Cope 1871, by original designation.

• **CONTENT.** A single polytypic species, *S. pygaea*, is recognized.

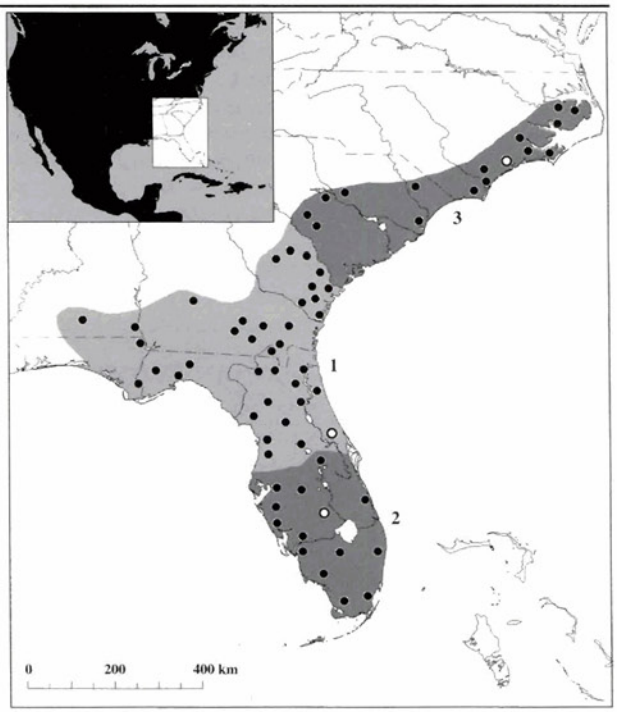
• **DEFINITION.** *Seminatrix pygaea* is a small black North American water snake with a bright red venter. The head is only slightly distinct from the cylindrical body. The eye is moderate in size (diameter about equal to eye–nostril distance) and the pupil is round. A maximum SVL length of 485 mm has been reported, but most adults are <400 mm. The tail is relatively short, making up 15–25% of TL.

Scutellation is relatively unmodified. The head has the nine typical caenophidian crown scutes. The only indication of aquatic adaptation is the slight narrowing of the anterior ends of the internasals. The rostral is rounded, the nasal single, and a loreal is present. The oculars usually are 1 + 2 and the temporals usually 1 + 2 or 1 + 1. The supralabials generally number 8, the infralabials 9. Two pairs of subequal genials are present. The dorsal scales are smooth, rounded, and without apical pits. The lower rows are widest and they become progressively narrower dorsally. Dorsal scales are smooth and usually in 17 rows at the neck and midbody, but in 15 rows just anterior to the vent, the reduction occurring by loss of the fourth row on either side. A few individuals have 19 rows on the neck (also reduced by loss of the fourth dorsal scale row). Dorsal scales superior to the vent are usually keeled in males. Some scales may appear keeled upon superficial examination due to a pale line running longitudinally through the center of the scale. Ventrals range from 112–134, the anal scute (cloacal scute) is generally divided, and 35–56 paired subcaudals are present, with the males having about 10 more than do females.

Teeth are found on all normally dentigerous bones: maxillary teeth number 19–21, increasing slightly in length posteriorly; palatine, 10–12; pterygoid, 17–18; dentary, 20–21, all subequal in length (Dowling 1950).

The presence of recurved hypapophyses on all body vertebrae, spinose and acalyculate hemipenes with enlarged basal hooks and a simple centripetal sulcus, together with reduction of dorsal scale rows by loss of a mid-lateral row, all serve to clearly identify *Seminatrix pygaea* as a member of the American subfamily Thamnophiinae (Natricidae) as shown by Rossman and Eberle (1977). This placement has been corroborated by electrophoretic (Dessauer et al. 1987, Dowling et al. 1996) and immunological (Dowling et al. 1983) studies.

• **DIAGNOSIS.** The only other predominately smooth-scaled American natricids are *Regina alleni* and *Virginia valeriae*. *Regina alleni* possesses a highly modified snout with a single internasal and nasals meeting one another dorsally, thereby separating the rostral from the internasal. *Virginia valeriae* lacks a preocular scute, thus allowing the loreal to enter the orbit. Thus, the paired internasals distinguish *Seminatrix* from *R. alleni*, and the presence of both a preocular and a loreal from *V. valeriae*. *Seminatrix* can be distinguished from juvenile *Farancia abacura* by the presence of a loreal, a divided anal scute (cloacal scute), and the lack of a ventral red and black checkerboard pattern.



MAP. Distribution of *Seminatrix pygaea*; circles represent type localities, dots indicate other records.

FIGURE 1. An adult *Seminatrix pygaea* from the Savannah River Site, Aiken County, South Carolina. Photograph by David E. Scott (1998).

• **DESCRIPTIONS, DISTRIBUTION, FOSSIL RECORD, PERTINENT LITERATURE.** See species account.

• **ILLUSTRATIONS.** The maxilla, body vertebra, and hemipenis illustrated here were previously published in Dowling and Duellman (1978).

• **REMARKS.** *Seminatrix pygaea* was first described by Cope

(1871) as a member of the genus *Contia*, which at that time was a nondescript group of small, smooth-scaled ground snakes that also included species now allocated to the Palearctic *Eirenis* and the Nearctic *Sonora*. However, when Boulenger (1893) assigned this species to the water snake genus *Tropidonotus* (because of hypapophyses retained on the posterior body vertebrae), Cope (1895) reassessed its relationships and agreed that it belonged with the water snakes, but he believed that it differed sufficiently from others to be placed in its own genus. Boulenger (1896) obviously did not agree, because he synonymized *Seminatrix*, along with *Regina* and *Thamnophis*, with his comprehensive genus *Tropidonotus*. Dunn (1928) followed Cope in placing *Seminatrix* in the Natricinae on the basis of its acalyculate hemipenis and hypapophyses on the posterior body vertebrae. Most recent workers have accepted this relationship.

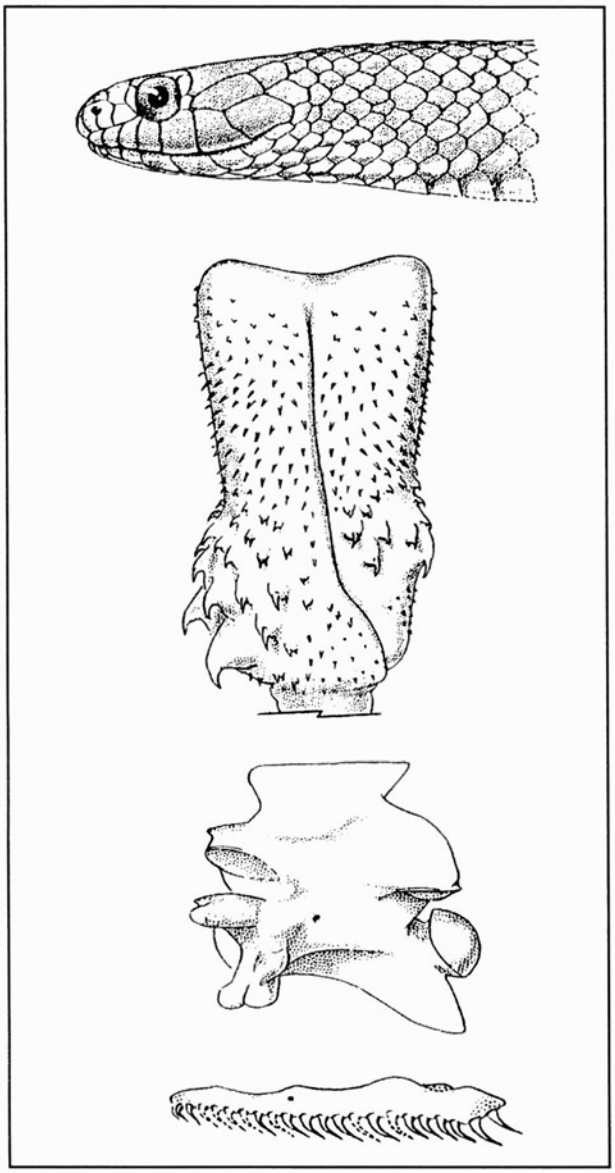


FIGURE 2. Morphology of *Seminatrix pygaea* (top to bottom): lateral view of the head (AMNH 68684); right hemipenis (LSUMZ Rt 1980; 6 SC); posterior body vertebra (AMNH 63872); left maxilla (AMNH 63872). The short, slightly bilobed hemipenes (6 subcaudals long), spinose with enlarged basal hooks, without calyces, and with a simple centripetal (medially trending) sulcus are typical of natricid snakes, as is the presence of a hypapophysis on the posterior (as well as anterior) body vertebrae. The nude apex of the hemipenis is typical of thamnophiines. Note that the maxillary teeth, although relatively uniform in length, have two (or three) at the posterior end that are longer. Drawings by Frances Waite (1971–1972).

The known morphological features corroborate the placement of *Seminatrix* as a natricid, but do not give a clear picture of its intergeneric relationships. Holman (1962) pointed out that *Seminatrix* agrees with two European species of *Natrix* (*N. natrix, N. tessellata*) and with American *N.* [= *Regina*] *septemvittata* and four species of *Thamnophis* in having moderately low neural spines (longer than high) on the body vertebrae. Four species of American *Natrix* [= *Nerodia*] differ in having neural spines much higher than long, and two species of *Storeria*, *Thamnophis brachystoma*, *Tropidoclonion lineatum*, and both species of *Haldea* [= *Virginia*] differ in having spines that are much lower. Auffenberg's (1963) placement was generally similar, although differing in detail. Rossman (1963) pointed out that *Seminatrix* agrees with *Natrix* [= *Nerodia*] and some species of *Thamnophis* in the possession of a median ventral keel on the parasphenoid and a ventral process on the basioccipital.

Neither scutellation nor osteology provide characters adequate to indicate intergeneric relationships. Not until hemipenial and chromosomal data were collated with cranial osteology (Rossman and Eberle 1977) did the North American natricids become clearly defined as separate from those on other continents and, therefore, were described as the tribe Thamnophiini. Dowling (in press) raised the subfamily Natricinae to familial rank (Natricidae) and the tribe to subfamilial rank (Thamnophiinae).

The immunological study (Dowling et al. 1983) showed *Seminatrix*, at 13 AID (Albumin Immunological Distances), to be slightly more distant from *Thamnophis sirtalis* than any of the ten species of the latter genus tested (1–10 AID), the three species of *Nerodia* (2–9 AID), and *Clonophis* (11 AID). However, *Seminatrix* proved to be about the same distance from *T. sirtalis* as *Regina alleni* (14 AID) and less distant than the two species of *Storeria* (19, 23 AID). This study also showed these Nearctic genera to differ strongly from the Oriental natricid *Xenochrophis* (39 AID) and the Ethiopian *Natriciteres* (46 AID). Snakes representing other families (including the Colubridae, *s.s.*) ranged 54–112 AID from *T. sirtalis*.

An electrophoretic study (Dessauer et al. 1987) showed a "low degree of molecular divergence" among 21 species of American natricids, including *Seminatrix*. This study also showed *Storeria* to be the most divergent within this group.

An electrophoretic study involving four "slow-evolving" genes (Dowling et al. 1996) further corroborated the placement of *Seminatrix* among North American natricids. The 39 species of natricids examined proved to be distinct from the other 176 species of snakes included in the study. Further, the genetic complement of *Seminatrix* (in the four genes utilized) was identical to that of *Clonophis*, *Regina alleni*, *Storeria occipitomaculata*, two species of *Virginia*, eight species of *Nerodia*, and 16 species of *Thamnophis*. In contrast, *Regina septemvittata* differed from those taxa by one allele and *R. rigida* by two.

These immunological and electrophoretic data show *Seminatrix* to be a typical member of a rather recent (Miocene–Pliocene) radiation of Nearctic natricid snakes, probably derived from a single Oriental entry. Like *Stilosoma* and *Regina alleni*, the geographic distribution of *Seminatrix* suggests that it became separated from its relatives by isolation on the "Florida Island," which existed during several periods in the late Cenozoic.

• **ETYMOLOGY.** The generic name *Seminatrix*, as used by Cope (1895), is a combination of the Latin prefix *semi*, meaning "half," and *nato*, meaning "to swim," from which is derived the genitive *natrix* from *natricis*, meaning "a water snake," alluding to its postulated relationship to water snakes (*Nerodia*). The name is of feminine gender.

Seminatrix pygaea (Cope)
Black Swamp Snake

Contia pygaea Cope 1871:223. Type locality, "Volusia, [Volusia Co.,] Florida." Holotype, Acad. Nat. Sci. Philadelphia (ANSP) 3533, a male collected by Edward Tatnell, date of collection unknown (examined by HGD).
Tropidonotus pygaeus: Boulenger 1893:228
Seminatrix pygaea: Cope 1895:678. Description of new genus.

• **CONTENT**. Three subspecies are currently recognized: *pygaea*, *paludis*, and *cyclas*.

• **DEFINITION.** See generic account.

• **DIAGNOSIS**. See generic account.

• **DESCRIPTIONS.** Descriptions of general morphological characters can be found in Cope (1871, 1891 [1892], 1895, 1898 [1900]), Garman (1884), Boulenger (1893), Loennberg (1894), Ditmars (1936, 1937, 1939), Schmidt and Davis (1941), Carr and Goin (1955), Wright and Wright (1957), Duellman and Schwartz (1958), Palmer (1963), Clark (1966), Mount (1975), Gibbons (1977), Martof et al. (1980), Ernst and Barbour (1989), and Palmer and Braswell (1995). Blaney (1977) described the micodermatoglyphics. Dowling (1950) described in detail variation among the three subspecies, including descriptions of scutellation, hemipenis, color pattern, and distribution.

• **ILLUSTRATIONS.** Photographs of *Seminatrix pygaea* can be found in Wright and Wright (1957), Mount (1975), Gibbons (1977), Martof et al. (1980), Ashton and Ashton (1981), and Tenant (1997). Drawings can be found in Schmidt and Davis (1941), Dowling (1950), Wright and Wright (1957), Ernst and Barbour (1989), Palmer and Braswell (1995), Conant and Collins (1998), and Powell et al. (1998). See generic account for illustrations of cephalic scales, hemipenis, vertebrae, and maxilla.

• **DISTRIBUTION.** *Seminatrix pygaea* occurs throughout peninsular Florida and the eastern portion of the Florida panhandle, the southeastern corner of Alabama, and the Lower Coastal Plain of the Carolinas and Georgia. The deepest known penetrations inland are by populations in Georgia (Lee County) and South Carolina (Aiken and Barnwell counties on the Savannah River Site, and Lexington and Richland counties near Columbia); all are approximately 150–180 km from the coast.

Seminatrix pygaea paludis, the northernmost form, is restricted to the Carolinas; *S. p. pygaea*, the central form, is found in Georgia, Alabama, and northern peninsular Florida as far south as Brevard and Pasco counties; *S. p. cyclas*, the southernmost form, is restricted to the lower half of peninsular Florida.

• **FOSSIL RECORD.** No fossils are known.

• **PERTINENT LITERATURE.** Major works on *Seminatrix pygaea* are limited. Dowling (1950) presented the most comprehensive review, his account included the description of the three subspecies, thorough discussions of the snake's origin, systematics, and distribution, and discussions of morphological variation across the range. Dowling (1950) also provided a key to subspecies and information on habitat preferences, movements, activity, parasites, diet, reproduction, and growth. Dodd (1993) described population structure, activity, and effect of drought on a population from Florida. Likewise, Seigel et al. (1995a) reported the effects of drought on movements of *S. pygaea* on the Savannah River Site near Aiken, South Carolina. Reproductive biology was described by Seigel et al. (1995b) and included information on reproductive cycles, brood sizes, offspring sizes, and the effects of drought on reproductive output. Descriptions of geographic variation in morphology, sexual dimorphism, and reproduction are provided by Loraine (1990).

The following represent notes and accounts on the natural history of *Seminatrix pygaea* and include field guides and similar sources: **summaries of natural history** (Wright and Wright 1957, Ernst and Barbour 1989, Palmer and Braswell 1995), **less detailed species accounts** (Ditmars 1936, 1937, 1939; Carr 1940; Schmidt and Davis 1941; Carr and Goin 1955; Martof 1956; Mount 1975; Stevenson 1976; Behler and King 1979; Linzey 1979; Martof et al. 1980; Ashton and Ashton 1981; Collins 1981; Smith and Brodie 1982; Jackson 1983; Merhtens 1987; Obst et al. 1988; Brothers 1992; Tennant 1997; Conant and Collins 1998), **morphology and body proportions** (Loennberg 1894, Clark 1966, Jackson et al. 1976, Fitch 1981, King 1989, Gibbons and Semlitsch 1991, Palmer and Braswell 1995), **details of distribution** (Cope 1877, 1888; Brimley 1910; Wright and Bishop 1915; Deckert 1918; Wright 1926; Corrington 1927, 1929; Stejneger and Barbour 1943; Neill 1951; Penney 1952; Wright and Wright 1952; Freeman 1955; Duellman and Schwartz 1958; Palmer and Whitehead 1960; Palmer 1963; Horton 1968; Mount 1975; Williamson and Moulis 1979, 1994a, b, c; Ashton and Ashton 1981; Braswell 1988; Palmer and Braswell 1995), **habitat use** (Loennberg 1894; Deckert 1918; Ditmars 1937, 1939; Carr 1940; Jobson 1940; Goin 1943; Neill 1951, 1958, 1964; Telford 1952; Carr and Goin 1955; Duellman and Schwartz 1958; Horton 1968; Scudder 1972; Mount 1975; Gibbons 1977; Laerm et al. 1980; Martof et al. 1980; Ashton and Ashton 1981; Wilson and Porras 1983; Dodd 1992; Smith and Franz 1994; Wilson 1995; Tennant 1997; Conant and Collins 1998), **activity and movement** (Carr 1940, Cooper 1948, Holman and Hill 1961, Dodd and Charest 1988, Gibbons and Semlitsch 1991, Dodd 1992), **diet** (Ditmars 1936, Rossman 1956, Duever 1967, Mount 1975, Brown 1979, Martof et al. 1980, Gibbons and Semlitsch 1991, Tennant 1997), **predation** (Kean and Tuberville 1995, Aycrigg et al. 1996), **parasites** (Yamaguti 1971, Goodman 1988), **mortality due to fire** (Vogl 1973), **defensive behavior** (Jackson et al. 1976), **tail breakage** (Spears 1977), **reproduction** (Ditmars 1936, Goin 1943, Dowling 1950, Fitch 1970, Godley 1982b, Iverson 1987, Palmer and Braswell 1995), **collecting methods** (Goin 1943, Godley 1982a, Gibbons and Semlitsch 1991), **size records** (Neill 1951, Kean and Tuberville 1995), **captive maintenance** (Rothman 1961, Mehrtens 1987, Rossi 1995), and **management and conservation** (Wilson and Porras 1983, Wilson 1995, Tennant 1997).

• **ETYMOLOGY.** The name *pygaea* is from the Greek *pyge* (rump or buttocks). Dowling (1950) interpreted this as a reference to the apparently abnormal compression of the posterior portion of the holotype. The name *cyclas* is from the Greek (garment ornamented with a border around the bottom) and refers to the ventral pattern in which dark markings form a border (Dowling 1950). The name *paludis* is from the Latin (swamp).

1. *Seminatrix pygaea pygaea* (Cope)

Contia pygaea Cope 1871:223. See species account.
Tropidonotus pygaeus: Boulenger 1893:228.
Seminatrix pygaea: Cope 1895:678.
Seminatrix pygaea pygaea: Dowling 1950:7. First use of trinomial.

• **DEFINITION.** This subspecies usually has 118–124 ventrals and a ventral color pattern consisting of long, narrow, curved black bars on the anterior portion of the ventral scales (or the venter may be immaculate).

2. *Seminatrix pygaea cyclas* Dowling

Seminatrix pygaea cyclas Dowling 1950:14. Type locality, "Indian Prairie, two to eight miles northeast of Lakeport, Glades County, Florida." Holotype, University of Michigan Museum of Zoology (UMMZ) 96301, a female collected by E. Ross Allen on 10 September 1947 (examined by HGD).

• **DEFINITION.** This subspecies usually has <119 ventrals and a red venter with extensions of the black dorsal pattern forming triangles on the anterolateral edge of each ventral. However, the ventral color pattern of *S. p. cyclas* can occur as a pattern variant in the other subspecies.

3. *Seminatrix pygaea paludis* Dowling

Seminatrix pygaea paludis Dowling 1950:12. Type locality, "Camp Davis, near Hollyridge, Onslow County, North Carolina." Holotype, University of Michigan Museum of Zoology (UMMZ) 91457, an adult female collected by Fred Barkalow, Jr., on 20 May 1942 (examined by HGD).

• **DEFINITION.** This subspecies usually has >126 ventrals.

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LITERATURE CITED

Ashton, R.E., Jr. and P.S. Ashton. 1981. Handbook of Reptiles and Amphibians of Florida. Part One. The Snakes. Windward Publ., Inc., Miami, Florida.

Auffenberg, W. 1963. The fossil snakes of Florida. Tulane Stud. Zool. 10:131–216.

Aycrigg, A.D., T.M. Farrell, and P.G. May. 1996. *Seminatrix pygaea pygaea*. Predation. Herpetol. Rev. 27:84.

Behler, J.L. and F.W. King. 1979. The Audubon Society Field Guide to North American Reptiles and Amphibians. Alfred A. Knopf, New York.

Blaney, P.K. 1977. A survey of the microornamentation of snake scales. M.S. Thesis. Louisiana St. Univ., Baton Rouge.

Boulenger, G.A. 1893. Catalogue of the Snakes in the British Museum (Natural History). Vol. 1. Trustees Brit. Mus. (Nat. Hist.), London.

—. 1896. Catalogue of the Snakes in the British Museum (Natural History). Vol. 3. Trustees Brit. Mus. (Nat. Hist.), London.

Braswell, A.L. 1988. A survey of the amphibians and reptiles of Nags Head Woods Ecological Preserve. Assoc. Southeast. Biol. Bull. 35: 199–217.

Brimley, C.S. 1910. Records of some reptiles and batrachians from the southeastern United States. Proc. Biol. Soc. Washington 23:9–18.

Brothers, D.R. 1992. An Introduction to Snakes of the Dismal Swamp Region of North Carolina and Virginia. Edgewood Probes, Inc., Boise, Idaho.

Brown, E.E. 1979. Some snake food records from the Carolinas. Brimleyana 1:113–124.

Carr, A.F., Jr. 1940. A contribution to the herpetology of Florida. Univ. Florida Publ. Biol. Sci. 3:1–118.

Carr, A. and C.J. Goin. 1955. Guide to the Reptiles, Amphibians and Fresh-water Fishes of Florida. Univ. Florida Press, Gainesville.

Clark, D.R., Jr. 1966. Notes on sexual dimorphism in tail-length in American snakes. Trans. Kansas Acad. Sci. 69:226–232.

Collins, H.H., Jr. 1981. Harper & Row's Complete Field Guide to North American Wildlife. Harper & Row, New York.

Conant, R. and J.T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd ed., exp. Houghton Mifflin Co., Boston, Massachusetts.

Cooper, B.W. 1948. An erythristic *Liodytes alleni*. Copeia 1948:304.

Cope, E.D. 1871. Ninth contribution to the herpetology of tropical America. Proc. Acad. Nat. Sci. Philadelphia 23:200–224.

—. 1877. Rare snakes from Florida. Amer. Nat. 11:565.

—. 1888. On the snakes of Florida. Proc.U.S. Natl. Mus.11:381–394 + 1 pl.

—. 1891 (1892). A critical review of the characters and variations of the snakes of North America. Proc. U.S. Natl. Mus. 14:589–694.

—. 1895. On some new North American snakes. Amer. Nat. 29:676–680.

—. 1898 (1900). The crocodilians, lizards and snakes of North America. Rept. U.S. Natl. Mus. (1898):153–1294 + 35 pl.

Corrington, J.D. 1927. *Seminatrix pygaea* in South Carolina. Copeia (161):185–187.

—. 1929. Herpetology of the Columbia, South Carolina, region. Copeia (172):58–83.

Deckert, R.F. 1918. A list of reptiles from Jacksonville, Florida. Copeia (54):30–33.

Dessauer, H.C., J.E. Cadle, and R. Lawson. 1987. Patterns of snake evolution suggested by their proteins. Fieldiana, Zool. 34:iii + 34 p.

Ditmars, R.L. 1936. The Reptiles of North America. Doubleday & Co., Inc. Garden City, New York.

—. 1937. Reptiles of the World. The Crocodilians, Lizards, Snakes, Turtles and Tortoises of the Eastern and Western Hemispheres. MacMillan Co., New York.

—. 1939. A Field Book of North American Snakes. Doubleday, Doran & Co., Garden City, New York.

Dodd, C.K., Jr. 1992. Biological diversity of a temporary pond herpetofauna in north Florida sandhills. Biodiv. Conserv. 1:125–142.

—. 1993. Population structure, body mass, activity, and orientation of an aquatic snake (*Seminatrix pygaea*) during a drought. Can. J. Zool. 71:1281–1288.

— and B.G. Charest. 1988. The herpetofaunal community of temporary ponds in North Florida sandhills: species composition, temporal use, and management implications, p. 87–97. *In* Management of Amphibians, Reptiles, and Small Mammals in North America: Proceedings of the Symposium, Flagstaff, Arizona. U.S.D.A. Forest Serv. Gen. Tech. Rep. RM-166. Rocky Mt. For. Range Exp. Sta., Ft. Collins, Colorado.

Dowling, H.G. 1950. Studies of the Black Swamp Snake, *Seminatrix pygaea* (Cope), with descriptions of two new subspecies. Misc. Publ. Mus. Zool. Univ. Michigan (76):1–38.

—. In press. A New Classification of Snakes: A Contribution to the Knowledge of Biodiversity. Krieger Publ. Co., Melbourne, Florida.

— and W.E. Duellman. 1978. Systematic Herpetology: A Synopsis of Families and Higher Categories. HISS Publ., New York.

—, C.A. Hass, S.B. Hedges, and R. Highton. 1996. Snake relationships revealed by slow-evolving proteins: a preliminary study. J. Zool. (London) 240:1–28.

—, R. Highton, G.C. Maha, and L.R. Maxson. 1983. Biochemical evaluation of colubrid snake phylogeny. J. Zool. (London) 201:309–329.

Duellman, W.E. and A. Schwartz. 1958. Amphibians and reptiles of southern Florida. Bull. Florida St. Mus. 3:181–324.

Duever, A.J. 1967. Trophic dynamics of reptiles in terms of the community food web and energy intake. M.S. Thesis, Univ. Georgia, Athens.

Dunn, E.R. 1928. A tentative key and arrangement of the American genera of Colubridae. Bull. Antivenin Inst. America 2:18–24.

Ernst, C.H. and R.W. Barbour. 1989. Snakes of Eastern North America. George Mason Univ. Press., Fairfax, Virginia.

Fitch, H.S. 1970. Reproductive cycles in lizards and snakes. Univ. Kansas Mus. Nat. Hist. Misc. Publ. (52):1–247.

—. 1981. Sexual size differences in reptiles. Univ. Kansas Mus. Nat. Hist. Misc. Publ. (70):1–72.

Freeman, H.W. 1955. The amphibians and reptiles of the Savannah River Project Area, Crocodilia, Sauria, and Serpentes. Part 3. Univ. South Carolina Publ. Ser. III, 1:275–291.

Garman, S. 1884. The reptiles and batrachians of North America. Part I. Ophidia. Mem. Mus. Comp. Zoöl. 8:xxxiv + 185 p. + 9 pl.

Gibbons, J.W. 1977. Snakes of the Savannah River Plant with Information about Snakebite Prevention and Treatment. ERDA Savannah River Environ. Res. Park, SRO-NERP-1.

— and R.D. Semlitsch. 1991. Guide to the Reptiles and Amphibians of the Savannah River Site. Univ. Georgia Press, Athens and London.

Godley, J.S. 1982a. Aquatic snakes in water hyacinth communities, p. 281–282. *In* D.E. Davis (ed.), CRC Handbook of Census Methods

for Terrestrial Vertebrates. CRC Press, Inc. Boca Raton, Florida.
—. 1982b. Predation and defensive behavior of the Striped Swamp Snake (*Regina alleni*). Florida Fld. Nat. 10:31–36.
Goin, C.J. 1943. The lower vertebrate fauna of the water hyacinth community in northern Florida. Proc. Florida Acad. Sci. 6:143–153.
Goodman, J.D. 1988. New auriculate telorchiid trematodes, including two new species of *Auritelorchis*, and erection of *Allotelorchis* n. gen. and Allotelorchiinae n. subf. (Trematoda: Telorchiidae). Trans. Amer. Microscop. Soc.107:362–368.
Holman, J.A. 1962. A Texas Pleistocene herpetofauna. Copeia 1962:255–261.
— and W.H. Hill. 1961. A mass unidirectional movement of *Natrix sipedon pictiventris*. Copeia 1961:498–499.
Horton, R.T. 1968. *Seminatrix pygaea* in Alabama. J. Herpetol. 1:94–95.
Iverson, J.B. 1987. Patterns of relative fecundity in snakes. Florida Sci. 50:223–233.
Jackson, J.F., I. Ingram, and H.W. Campbell. 1976. The dorsal pigmentation pattern of snakes as an antipredator strategy: a multivariate approach. Amer. Nat. 110:1029–1053.
Jackson, J.J. 1983. Snakes of the Southeastern United States. Coop. Ext. Serv., Univ. Georgia Coll. Agric., Athens.
Jobson, H.G.M. 1940. Reptiles and amphibians from Georgetown County, South Carolina. Herpetologica 2:39–43.
Kean, C.A. and T.D. Tuberville. 1995. *Seminatrix pygaea*. Size. Herpetol. Rev. 26:103.
King, R.B. 1989. Sexual dimorphism in snake tail length: sexual selection, natural selection, or morphological constraint? Biol. J. Linnean Soc. 38:133–154.
Laerm, J., B.J. Freeman, L.J. Vitt, J.M. Meyers, and L. Logan. 1980. Vertebrates of the Okefenokee Swamp. Brimleyana 4:47–73.
Linzey, D.W. 1979. Snakes of Alabama. Strode Publ., Inc. Huntsville, Alabama.
Loennberg, E. 1894. Notes on reptiles and batrachians collected in Florida in 1892 and 1893. Proc. U.S. Natl. Mus.17:317–339.
Loraine, R.K. 1990. A geographic analysis of sexual dimorphism and morphological variation in *Seminatrix pygaea* (Cope). M.S. Thesis, Univ. South Florida, Tampa.
Martof, B.S. 1956. Amphibians and Reptiles of Georgia: A Guide. Univ. Georgia Press, Athens.
—, W.M. Palmer, J.R. Bailey, J.R. Harrison, III, and J. Dermid. 1980. Amphibians and Reptiles of the Carolinas and Virginia. Univ. North Carolina Press, Chapel Hill.
Mehrtens, J.M. 1987. Living Snakes of the World in Color. Sterling Publ. Co., Inc. New York.
Mount, R.H. 1975. The Reptiles and Amphibians of Alabama. Auburn Univ. Agric.Exp. Sta., Auburn, Alabama.
Neill, W.T. 1951. Notes on the natural history of certain North American snakes. Publ. Res. Div. Ross Allen's Rept. Inst. 1:47–60.
—. 1958. The occurrence of amphibians and reptiles in saltwater areas, and a bibliography. Bull. Marine Sci. Gulf Carib. 8:1–97.
—. 1964. Viviparity in snakes: some ecological and zoogeographical considerations. Amer. Nat. 98:35–55.
Obst, F.J., K. Richter, and U. Jacob. 1988. The Completely Illustrated Atlas of Reptiles and Amphibians for the Terrarium. T.F.H. Publ., Inc., Neptune City, New Jersey.
Palmer, W.M. and A.L. Braswell. 1995. Reptiles of North Carolina. Univ. North Carolina Press, Chapel Hill.
— and J.R. Paul. 1963. The Black Swamp Snake, *Seminatrix pygaea paludis* Dowling, in North Carolina. Herpetologica 19:219–221.
— and D.E. Whitehead. 1960. A range extension of the Swamp Snake, *Seminatrix pygaea paludis* Dowling. Herpetologica 16:201.
Penney, J.T. 1952. Distribution and bibliography of the amphibians and reptiles of South Carolina. Univ. South Carolina Publ. Ser. III. Biol. 1:1–28.
Powell, R., J.T. Collins, and E.D. Hooper, Jr. 1998. A Key to Amphibians and Reptiles of the Continental United States and Canada. Univ. Kansas Press, Lawrence.
Rossi, J.V. and R. Rossi. 1995. Snakes of the United States and Canada: Keeping Them Healthy in Captivity. 2 vol. Krieger Publ. Co., Malabar, Florida.
Rossman, D.A. 1956. Notes on food of a captive Black Swamp Snake, *Seminatrix pygaea pygaea* (Cope). Herpetologica 12:154–155.
—. 1963. Relationships and taxonomic status of the North American natricine snake genera *Liodytes*, *Regina*, and *Clonophis*. Occ. Pap. Mus. Zool., Louisiana St. Univ., Baton Rouge (29):1–29.
— and W.G. Eberle. 1977. Partition of the genus *Natrix*, with preliminary observations on evolutionary trends in natricine snakes. Herpetologica 33:34–43.
Rothman, N. 1961. Mud, Rainbow and Black Swamp snakes in captivity. Bull. Philadelphia Herpetol. Soc. 9:17–20.
Schmidt, K.P. and D.D. Davis. 1941. Field Book of Snakes of the United States and Canada. G.P. Putnam's Sons, New York.
Scudder, S. and K. Bourgeois. 1972. Observations on snakes in the burrows of mole crickets. Bull. Maryland Herpetol. Soc. 8:95.
Seigel, R.A., J.W. Gibbons, and T.K. Lynch. 1995a. Temporal changes in reptile populations: effects of a severe drought on aquatic snakes. Herpetologica 51:424–434.
—, R.K. Loraine, and J.W. Gibbons. 1995b. Reproductive cycles and temporal variation in fecundity in the Black Swamp Snake, *Seminatrix pygaea*. Amer. Midl. Nat. 134:371–377.
Smith, H.M. and E.D. Brodie, Jr. 1982. A Guide to Field Identification: Reptiles of North America. Golden Press, New York.
Smith, L.L. and R. Franz. 1994. Use of Florida round-tailed muskrat houses by amphibians and reptiles. Florida Fld. Nat. 22:69–74.
Spears, G. 1977. Predation on colubrid snakes. M.S. Thesis, Univ. Florida, Gainesville.
Stejneger, L. and T. Barbour. 1943. A check list of North American amphibians and reptiles. 5th ed. Bull. Mus. Comp. Zoöl. 93:xix + 260 p.
Stevenson, H.M. 1976. Vertebrates of Florida: Identification and Distribution. Univ. Presses Florida, Gainesville.
Telford, S.R., Jr. 1952. A herpetological survey in the vicinity of Lake Shipp, Polk County, Florida. Quart. J. Florida Acad. Sci. 15:175–185.
Tennant, A. 1997. A Field Guide to Snakes of Florida. Gulf Publ. Co., Houston, Texas.
Vogl, R.J. 1973. Effects of fire on the plants and animals of a Florida wetland. Amer. Midl. Nat. 89:334–347.
Williamson, G.K. and R.A. Moulis. 1979. Distribution of Georgia amphibians and reptiles in the Savannah Science Museum Collection. Savannah Sci. Mus. Inc. Spec. Publ. (1), Savannah, Georgia.
— and —. 1994a. Herpetological Specimens in the Savannah Science Museum Collection. Vol. 2. Reptiles. Savannah Sci. Mus. Inc. Spec. Publ. (2), Savannah, Georgia.
— and —. 1994b. Distribution of Amphibians and Reptiles in Georgia. Vol. 1. Maps. Savannah Sci. Mus. Inc. Spec. Publ. (3), Inc. Savannah, Georgia.
— and —. 1994c. Distribution of Amphibians and Reptiles in Georgia. Vol. 2. Locality Data. Savannah Sci. Mus. Inc. Spec. Publ. (3), Savannah, Georgia.
Wilson, L.A. 1995. Land Manager's Guide to the Amphibians and Reptiles of the South. Nature Conserv. and U.S. For. Serv., S. Reg., Chapel Hill, North Carolina, and Atlanta, Georgia.
Wilson, L.D. and L. Porras. 1983. The Ecological Impact of Man on the South Florida Herpetofauna. Univ. Kansas Mus. Nat. Hist. Spec. Publ. (9):vi + 89 p.
Wright, A.H. 1926. The vertebrate life of Okefeenokee Swamp in relation to the Atlantic Coastal Plain. Ecology 7:77–95.
— and S.C. Bishop. 1915. A biological reconnaissance of the Okeefenokee Swamp in Georgia: snakes. Proc. Acad. Nat. Sci. Philadelphia 67:139–192 + 3 pl.
— and A.A. Wright. 1952. List of the snakes of the United States and Canada by states and provinces. Amer. Midl. Nat. 48:574–603.
— and —. 1957. Handbook of Snakes of the United States and Canada. Vol. 2. Comstock Publ. Assoc., Ithaca, New York.
Yamaguti, S. 1971. Synopsis of Digenetic Trematodes of Vertebrates. Vol. 1. Keigaku Publ. Co., Tokyo.

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